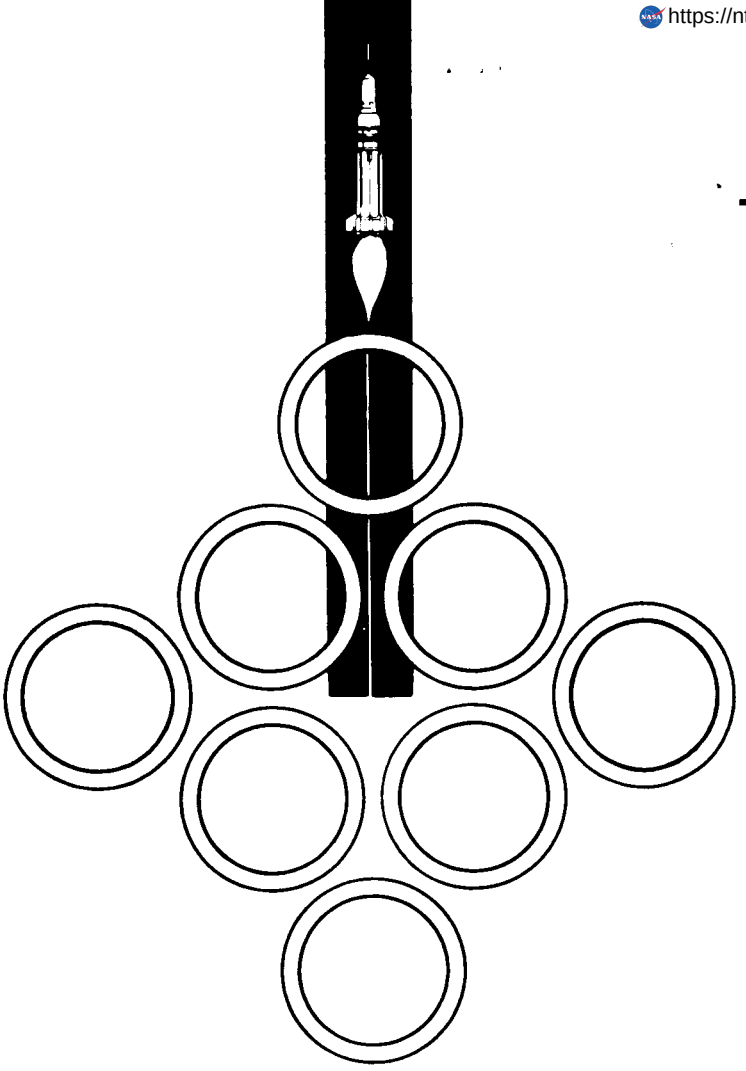

ENGINEERING DEPARTMENT

TECHNICAL MANUAL

SDES-64-415

Saturn I

LAUNCH VEHICLE SA-10 AND LAUNCH COMPLEX 37B FUNCTIONAL SYSTEMS DESCRIPTION

Volume I

RP-1 FUEL SYSTEM FUNCTIONAL DESCRIPTION, INDEX OF FINDING NUMBERS, AND MECHANICAL SCHEMATICS

SPACE DIVISION CHRYSLER CORPORATION

SDES-64-415

SATURN I
LAUNCH VEHICLE SA-10
AND
LAUNCH COMPLEX 37B
FUNCTIONAL SYSTEMS DESCRIPTION

VOLUME I
RP-1 FUEL SYSTEM
FUNCTIONAL DESCRIPTION, INDEX OF FINDING NUMBERS, AND MECHANICAL SCHEMATICS

JULY 1964

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

FOREWORD

This volume is one of a set of eleven volumes that describe mechanical and electro-mechanical systems of the Saturn I, SA-10 launch vehicle and launch complex 37B. The eleven-volume set is prepared for the Functional Integration Section, Systems Integration & Operations Branch, Vehicle Systems Division, P&VE Laboratory, MSFC, by Systems Engineering Branch, Chrysler Corporation Space Division under Contract NAS 8-4016. Volume titles are listed below:

Volume I	RP-1 Fuel System
Volume II	LOX System
Volume III	LH_2 System
Volume IV	Nitrogen and Helium Storage Facility
Volume V	Pneumatic Distribution System
Volume VI	Environmental Conditioning Systems
Volume VII	Launch Pad Accessories
Volume VIII	H-1 Engine and Hydraulic System
Volume IX	RL10A-3 Engine and Hydraulic System
Volume X	Separation and Flight Termination Systems
Volume XI	Supplement: Legend and Composite Schematic

The technical content of this volume reflects the most up-to-date design information available from the S-I/S-IB Project Engineer, R-P&VE on April 15, 1964.

System mechanical schematics are provided in section 3 to support the functional description of the system. The index of finding numbers in section 2 provides physical and functional descriptions of components identified on the schematics.

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SECTION 1

FUNCTIONAL DESCRIPTION

1.1 INTRODUCTION N65-23184

The Saturn I launch vehicle SA-10 and launch complex 37B RP-1 fuel system, as described in this volume, includes launch complex equipment involved in the prelaunch fueling of the S-I stage, and S-I stage equipment that stores and pressurizes fuel received from the launch complex and controls fuel supply to the S-I stage propulsion system during S-I stage flight. Specifically excluded from this description are one-shot safety devices, such as burst diaphrams, and subsystems or components used exclusively for maintenance of launch complex equipment.

Figure 1-1 identifies system equipment with respect to both location and functional subsystem arrangement. This functional description describes the system and system functions in terms of an abort-free prelaunch countdown, vehicle launch, and S-I stage flight and assumes that both the launch complex and the launch vehicle are in a state of readiness for prelaunch countdown. Author

1.2 SYSTEM FUNCTIONS

The three functions of the fuel system are: the storage of sufficient fuel for filling the S-I stage fuel tanks, the transfer of fuel between the fuel storage area and the S-I stage fuel tanks, and the supply of fuel to the engines during vehicle flight.

For the description of these functions, the fuel system is divided into functional subsystems as shown in figure 1-1.

1.2.1 Fuel Storage - Fuel is transferred from mobile tankers to a 56,500 gallon fuel storage tank in the fuel storage subsystem where the fuel is stored and conditioned for subsequent transfer to the S-I stage.

1.2.2 Fuel Transfer - Fuel transfer is accomplished in four operations: fill, adjust level drain, replenish, and drain. These operations are initiated and controlled from the launch control center (LCC). From the LCC, each operation can be sequenced automatically or manually, or can be simulated to verify the system operation without fuel transfer.

1.2.2.1 Fill. The fill operation transfers fuel from the fuel storage and transfer facility through the transfer lines and into the fuel tanks. This operation is accomplished in three sequences: fast fill, slow fill, and line drain. During fast fill, fuel flows through the fast fill transfer control at the rate of 2000 gallons per minute. When the tanks are 98 percent filled, fast fill is terminated and slow fill is initiated. During slow fill, fuel flows through the slow fill transfer control at the rate of 200 gpm. Fuel transfer at the slow rate continues until the tanks are overfilled to approximately

101 percent of a predetermined fuel level. This predetermined fuel level is calculated to provide the correct mass loading of fuel at a nominal fuel density.

Because actual fuel density is usually less than this nominal value, the tanks are overfilled to compensate for density variations and insure that a sufficient fuel mass is loaded during the initial filling operation. Later in the countdown sequence, the actual density is determined; a new fuel level is calculated, and excess fuel is drained from the tanks. Upon completion of slow fill, line drain is initiated to drain residual fuel from the transfer lines.

1.2.2.2 Level Adjust Drain. The level adjust drain operation permits excess fuel to be drained from the S-I stage fuel tanks and transferred back to the storage facility through the transfer line level adjust control. Normally this is the final fuel transfer operation in a countdown sequence. The amount of excess fuel drained during this operation is determined by a tanking computer. The computer controls the level adjust regulator and terminates the sequence when the excess fuel has been drained.

1.2.2.3 Replenish. The replenish operation is used for adding fuel to the S-I fuel tanks when last-minute changes in vehicle fuel requirements necessitate the addition of fuel after the level adjust drain operation has been performed. In the first phase of replenish, the transfer lines are filled at a rapid rate (2000 gallons per minute) before fuel is transferred into the fuel tanks. After the transfer lines are filled, fuel is pumped through the transfer line slow fill control and into the fuel tanks at 200 gallons per minute. When the tanking computer senses that the tanks are 100 percent filled with respect to the new fuel level requirement, replenish is terminated and the transfer lines are again drained.

1.2.2.4 Drain. During the drain operation, fuel is drained from the S-I stage fuel tanks and transferred back to the fuel storage tank. This operation is not part of the normal countdown sequence and is performed only in the event of a launch cancellation.

1.2.3 Engine Fuel Supply - Engine fuel supply functions begin just prior to H-1 engine ignition and are terminated at engine cutoff. These functions include a fuel bubbling operation, fuel tank pressurization operations, and H-1 engine fuel supply and shutoff operations.

1.3 SYSTEM DESCRIPTION

1.3.1 Storage Equipment - The RP-1 fuel system storage equipment consists of a 56,500 gallon storage tank, a filter-separator unit, and connecting networks required for filling and draining the storage tank and routing fuel to the transfer equipment.

1.3.2 Transfer Equipment (Figures 1-1 and 3-1)

1.3.2.1 Transfer Pump. The line pressure and flow necessary for transferring fuel between the RP-1 fuel storage tank and the S-I stage fuel tanks are provided by Transfer Pump A502 and Transfer Pump Motor A504. The transfer pump is capable

of pumping fuel through the transfer lines at 2000 gpm and 175 psig. The transfer pump is electrically interlocked with fuel transfer sequences which are initiated and controlled from the RP-1 control and the RP-1 components panels in the LCC.

1.3.2.2 Fast Fill Control. The fast fill control consists of Pneumatic Valve A517 and Orifice A550. During fast fill, the valve is opened by a pneumatic control pressure from the RP-1 pneumatic control console and provides a 2000-gpm flow of fuel from fuel transfer Pump A502 to the S-I stage fuel tanks.

1.3.2.3 Slow Fill Control. Pneumatic Valve A521 and Orifice A551 comprise the slow fill control. Pneumatic Valve A521 is in the main fuel transfer line and is controlled by pneumatic pressure from the RP-1 pneumatic control console. When opened, the valve allows fuel discharge from Transfer Pump A502 to flow to the S-I stage fuel tanks. Orifice A551, downstream from the valve, restricts fuel flow to 200 gpm.

1.3.2.4 Power Drain Control. The power-drain control consists of ball-type Pneumatic Valve A518. This valve operates in conjunction with line drain Pneumatic Valve A520 to provide a rapid transfer of fuel from the S-I stage to the storage tank during a line drain sequence or an automatic drain sequence. Pneumatic Valve A518 is controlled by pneumatic pressure from the RP-1 pneumatic control console.

1.3.2.5 Level Adjust Control. The level adjust control controls the draining of fuel from the S-I stage fuel tanks during level adjust drain and automatic drain sequences. The level adjust control consists of Flow Regulator A522 and Pneumatic Relay A559. The flow regulator is controlled by differential pneumatic pressure applied across the regulator dome. The differential pressure is controlled by the pneumatic relay, which, in turn, is controlled by a signal from Fuel Tanking Computer A506. Depending on the magnitude of the tanking computer signal, the pneumatic relay regulates the differential pressure across the regulator dome between 3 and 15 psig. When the fuel tanks are drained to the 101-percent-full level, the tanking computer signal to the pneumatic relay gradually reduces the differential pressure across the regulator dome. This action reduces flow through the regulator and terminates flow when the tanks are drained to the 100-percent-full level.

1.3.2.6 Line Drain Control. The line drain control is used to drain fuel from the transfer lines during an automatic drain sequence and upon termination of a fill sequence or a replenish sequence. Pneumatic Valve A520 and Jet Eductor A514 comprise the line drain control. During line drain, fuel is pumped through the valve and the jet eductor. Fuel flow through the jet eductor causes a suction that draws residual fuel from the transfer lines.

1.3.3 Control Equipment and Subsystems (Figures 1-1 and 3-2)

1.3.3.1 RP-1 Pneumatic Control Console. The RP-1 pneumatic control console provides regulation, control, and distribution of gaseous nitrogen (GN_2) for the operation of valves in the fuel transfer subsystem. The console reduces a 3500-psig supply of GN_2 from the nitrogen and helium storage facility (volume IV) to 750-psig and distributes

this supply pressure to individual solenoid valves. The solenoid valves are individually controlled by sequence signals from the RP-1 control equipment located in the LCC, and supply 750-psig GN_2 control pressure to the following fuel transfer valves: fast fill Pneumatic Valve A517, slow fill Pneumatic Valve A521, power drain Pneumatic Valve A518, and line drain Pneumatic Valve A520.

1.3.3.2 RP-1 Control Panel. The RP-1 control panel is located in the fuel control center of the LCC and is used for initiating the sequential progression of the fill, level adjust drain, replenish, and drain operations. Functions of controls on this panel are listed below.

a. The POWER switch controls electrical power to other components in the panel.

b. The four-way FUNCTION SELECTOR switch is used for selecting one of three modes of fuel system operation: operate, simulate, or manual. With the switch at the OPERATE position, the fuel system is set for automatic and sequential operation. At the SIMULATE position, the switch provides for automatic and sequential operation of the system to verify system components. This mode of operation is similar to the operate mode except that the fuel transfer pumps are not operated and no fuel is transferred. When placed to the MANUAL position, the switch transfers control to the RP-1 components panel for manual operation of individual components.

c. The FILL pushbutton is used to initiate the automatic fuel filling operation. As previously described, the operation consists of a fast fill sequence, a slow fill sequence, and a line drain sequence. Once the FILL pushbutton switch is depressed, progressions from one sequence to the next are automatic.

d. The SLOW FILL pushbutton switch initiates the slow fill sequence.

e. The ADJUST LEVEL DRAIN pushbutton switch initiates the draining of excess fuel from the S-I stage tanks and transfers control of the level adjust drain operation to a three-way toggle switch. At the LINE INERT position, the switch initiates a sequence for draining the fuel filling mast and fuel transfer line upon termination of the level adjust drain sequence. At the RESET position, the switch reverts the level adjust drain sequence to a standby condition so the sequence can be repeated as necessary.

f. The MAST PURGE TOGGLE switch initiates a manual purge of the fuel transfer line and the fuel filling mast.

g. The REPLENISH pushbutton initiates the automatic replenish operation. The operation consists of a transfer line fill sequence, a replenish sequence, and a transfer line drain sequence which is performed after the fuel tanks have been replenished.

h. The DRAIN pushbutton initiates automatic draining of the S-I stage fuel tanks.

i. The RP-1 BUBBLING toggle switch initiates the manual or automatic bubbling operation. At the MANUAL position, the switch provides for fuel bubbling checkout. With the switch positioned to AUTO, fuel bubbling is automatically initiated during the countdown sequence.

1.3.3.3 RP-1 Components Panel. The RP-1 components panel is located in the LCC and provides switches and controls for manual operation of components within the fuel transfer subsystem. These switches and controls become functional only when the four-way FUNCTION SELECTOR switch on the RP-1 control panel is turned to the MANUAL position.

1.3.3.4 Fuel Density Computer Subsystem. The fuel density computer subsystem consists of three primary units: Fuel Density Computer A507, the fuel density computer panel, and a digital indicator panel. The fuel density computer is located on the second floor of the AGCS building; the fuel density computer panel and the digital indicator panel are located in LCC propellant loading rack assembly No. 2.

The fuel density computer subsystem measures the density of fuel within the S-I stage fuel tanks and computes the percentage difference between measured density and a nominal density as assumed for preliminary fuel tanking operations. The percentage difference between the density values is used in conjunction with propellant loading tables to determine a differential pressure correction factor that is programed into the fuel tanking computer. The fuel tanking computer uses the correction factor as the basis for making final adjustments to the S-I stage fuel load.

The density computer determines fuel density by measuring the differential pressure across a known volume of fuel in tank F-4 and comparing the measured pressure with a differential pressure predetermined for the same volume of fuel at a nominal specific gravity of 0.810. A pressure transducer within the density computer measures the pressure differential between one of four pressure probes which extend to different depths in the upper region of the tank, and one that extends to the bottom of the tank. One of the four upper probes is preselected for use in taking this pressure measurement on the basis of predetermined mission fuel level. Since the exact displacement between each upper probe and the lower probe is known, it follows that the differential pressure is measured with respect to a known volume of fuel. Any difference between the measured differential pressure and the predetermined differential pressure reflects a proportional deviation in fuel density from a nominal specific gravity of 0.810. The predetermined differential pressure is preset into the fuel density computer before the computer is delivered to the launch site.

The fuel density computer panel provides a direct indication of the fuel density differential pressure programed into the density computer. The fuel density digital indicator panel displays the actual density of fuel within the fuel tanks. Actual density is indicated as a percentage of the nominal specific gravity programed into the fuel density computer, and is based on the predetermined differential pressure indication that appears on the fuel density computer panel.

1.3.3.5 Fuel Tanking Computer Subsystem. The fuel tanking computer subsystem regulates the amount of fuel loaded into the S-I stage fuel tanks with respect to the fuel mass requirements of a given mission. The system consists of Fuel Tanking Computer A506, a fuel tanking computer panel, and a digital indicator panel. The fuel tanking computer is located on the second floor of the AGCS building; the tanking computer panel and digital indicator panel are located in LCC propellant loading rack assembly No. 2.

The tanking computer regulates the amount of fuel loaded into the fuel tanks with respect to predetermined fuel pressure heads for fuel in tank F-4. The computer incorporates a pressure transducer that senses the differential pressure between a pressure probe located in the ullage of tank F-4 and one near the bottom of the tank. The lower probe is also used by the fuel density computer in determining fuel density. The measured differential pressure represents the fuel pressure head in the tank minus the ambient pressure in the tank ullage. Before delivery to the launch site, the computer is programed to halt the slow fill sequence when the measured fuel pressure head reaches a predetermined value. This predetermined head pressure is based on mission fuel mass requirements, a nominal fuel specific gravity of 0.810, and a ±0.465 psig fuel differential pressure correction factor that provides for initial overfilling of the tanks. Before the fill operation is initiated, 98 percent of this predetermined differential pressure is programed into the computer. The same percentage of the predetermined pressure head is displayed on the fuel tanking digital indicator panel.

During the fill operation, computer command signals effect control of transfer line components through AGCS relay logic networks and the RP-1 pneumatic control console.

Upon termination of the slow fill sequence, a differential pressure correction is dialed into the fuel tanking computer panel to compensate for the difference between nominal fuel density and actual fuel density. The pressure correction is taken from propellant loading tables and is based on the actual fuel density indication displayed on the fuel density indicator panel. With the pressure correction programed into the computer, the fuel quantity digital indicator panel indicates the existing fuel level as a percentage of the corrected differential pressure requirement. The percentage indication is normally greater than 100 percent (approximately 102 percent) because the tanks are initially overfilled. During the level adjust drain sequence, excess fuel is drained from the tanks until the tanking computer senses the required differential fuel pressure head in fuel tank F-4. Throughout this sequence, the tanking computer controls level adjust drain components in the transfer subsystem and halts the draining of fuel when the fuel quantity digital indicator panel indicates that the tanks are 100 percent full. The fuel tanking computer panel has two manually set digital readouts.

One readout scale, marked FUEL DIFFERENTIAL PRESSURES (PSI), is preset for the nominal fuel tank differential pressure. The other scale, marked PRESSURE CORRECTION (PSI), is adjustable plus or minus 0.465 psig for differential pressure corrections based on fuel density deviations. A telephone-type dial and a positive or negative selector switch are used for entering differential pressure corrections.

The fuel quantity digital indicator panel indicates the quantity of fuel in tank F-4 as a percentage of the preset differential pressure indicated on the fuel tanking computer panel.

1.3.4 S-I Stage Components and Subsystems - The major components and subsystems which form the S-I stage portion of the fuel system are identified in figures 1-1 and 3-2 and are described below.

The S-I stage contains four fuel tanks which supply fuel for H-1 engine operation. Each tank supplies fuel to one outboard engine and one inboard engine. The four tanks are alternately arranged with four LOX tanks in a circular pattern about a center LOX tank. A common manifold interconnects the ullage area of the four tanks to maintain equal ullage pressure. A similar manifold interconnects the lower portions of the tanks to maintain an equal fuel level within the tanks. Fuel level sensors, located in the bottom of fuel tanks F-2 and F-4, sense fuel depletion to initiate inboard and outboard engine shutdown. Also located in fuel tank F-4 are differential pressure probes which provide fuel pressure data for determining fuel density and fuel levels during fuel tanking operations. The fuel tank pressurization subsystem regulates pressure within the fuel tanks to maintain a constant net positive fuel pressure head during vehicle flight. The subsystem contains two high-pressure spheres which are filled with 3000-psig GN_2 for in-flight pressurization of the tanks. GN_2 from these spheres is introduced into the upper fuel tank interconnecting manifold through three electromechanical valves. The valves are controlled by a pressure switch that monitors fuel tank pressure. From the lower manifold, fuel is supplied to each H-1 engine by a single suction line. Normally closed Pneumatic Valves (prevalves) B103 are pressure operated to the open position during fill sequences and during engine operation but are released to the closed position at engine shutdown or in the event of engine malfunction.

1.4 SYSTEM OPERATIONS

RP-1 fuel system operations are identified with respect to the three functions of the system: fuel storage, fuel transfer, and engine fuel supply. The operations and sequences involved in the performance of these functions are described separately in terms of component operation.

1.4.1 Storage Operations - Storage operations include a storage tank filling sequence and a fuel filtration sequence. In the storage tank filling sequence, Storage Tank A501 is filled with 56,500 gallons of fuel from service trailers. During the fuel filtration sequence, fuel in the storage tank is circulated through a filter-separator unit that filters foreign matter from the fuel and removes water mixed with the fuel due to condensation within the storage tank.

1.4.2 Transfer Operations (Figures 3-1 and 3-2) - Transfer operations include those necessary for filling or draining the S-I stage fuel tanks. These operations are the fill, level adjust drain, replenish, and drain operations described in paragraph 1.2. Although the operations can be performed manually or automatically, only the automatic operations are discussed.

1.4.2.1 Fill. The automatic fill operation includes the fast fill, slow fill, and line drain sequences described in paragraph 1.2. The fast fill sequence fills the fuel tanks to 98 percent of a predetermined level and is immediately followed by a slow fill sequence that overfills the tanks to approximately 101 percent of the predetermined fuel level.

a. Initial Setup. The following operations are performed before the fast fill sequence is initiated.

1. The fuel filling mast is manually connected to the S-I stage fill and drain Quick-Disconnect Coupling B112.

2. Manual Valves A523 and A524 on fuel Storage Tank A501 are opened.

3. Manual Valve A591 is closed, and Manual Valve A590 is opened.

4. Manual Valves A573 and A530 are opened.

5. Power switches on the RP-1 control panel, fuel tanking computer panel, and fuel density computer panel are turned to the POWER position.

6. The fuel density computer panel is set to indicate the differential pressure programed into the fuel density computer.

7. All other manual valves and pneumatic valves in the transfer subsystem remain closed.

b. Fast Fill. The fast fill sequence occurs as follows:

1. The fast fill sequence is initiated at the RP-1 control panel by turning the FUNCTION SELECTOR switch to the OPERATE position and depressing the FILL pushbutton.

2. Fast fill Pneumatic Valve A517 and slow fill Pneumatic Valve A521 are opened by 750-psig GN_2 inputs from Solenoid Valves A2869 and A2871, respectively.

3. Booster line Pneumatic Valve A519 is opened by a 750-psig GN_2 control pressure from valve panel No. 5 (volume V).

4. Fuel fill and drain Pneumatic Valve B111 is opened by a 750-psig GN_2 control pressure from the launcher manifold through Quick-Disconnect Couplings A6501 and B101.

5. Fuel vent Pneumatic Valves B260-1 and B260-2 are opened by a 750-psig GN_2 control pressure from valve panel No. 9 (volume V).

6. A signal from the RP-1 control panel starts Transfer Pump A502.

7. Fuel flows by gravity through Manual Valve A523 to Transfer Pump A502 where it is discharged into the transfer line at 2000 gpm and approximately 175 psig. Thermal Switch A578 stops the pump motor if fuel temperature reaches 107 F. When fuel discharge pressure rises to 39 (±4) psig, Pressure Switch A566 actuates and sends a signal to the fuel control center to indicate that the pump is operating properly.

8. Relief Valve A546 relieves line pressure in excess of 60 psig to the storage tank.

9. Fuel flows through Strainer A511, Pneumatic Valve A517, Pneumatic Valve A521, Orifices A550 and A551 to discharge Pneumatic Valve A516.

10. From Pneumatic Valve A516 fuel flows to the fuel filling mast through Manual Valve A590 and Pneumatic Valve A519. Relief Valve A593 protects the transfer line downstream from Manual Valve A590 by venting fuel pressure in excess of 60 psig into the upstream portion of the line. Strainer A575 removes solid particles from the fuel.

11. Air Eliminator A557 and Air Vent A558 remove air from the fuel in the transfer line. Fuel pressure in the air eliminator in excess of 5 psig is vented to the transfer line through Relief Valve A602.

12. Fuel flows through the filling mast and into tank F-1 through Retractable Coupling Assembly A4500, Quick-Disconnect Coupling B112 and fill and drain Pneumatic Valve B111. The position of Pneumatic Valve B111 is monitored throughout the filling sequence.

13. Fuel flows from tank F-1 into tanks F-2, F-3, and F-4 through the lower fuel tank manifold.

14. Air displaced by the rising fuel level is discharged through fuel vent Pneumatic Valves B260-1 and B260-2. The position of the fuel vent valves is monitored throughout the tanking operations.

c. Slow Fill. The slow fill sequence is initiated when Fuel Tanking Computer A506 senses that the tanks are 98 percent full. The slow fill sequence occurs as follows:

1. Upon sensing that the fuel tanks are 98 percent full, Fuel Tanking Computer A506 transmits to the RP-1 control panel a signal that causes fast fill Pneumatic Valve A517 to close.

2. With Pneumatic Valve A517 closed, fuel discharge into the main transfer line is entirely through slow fill Pneumatic Valve A521 and Orifice A551.

3. Fuel flow into the fuel tanks continues as in the fast fill sequence, but flow rate is reduced to 200 gpm by Orifice A551.

4. As the filling operation progresses, the fuel tanking digital indicator panel indicates the percentage to which the tanks are filled.

5. Pneumatic Valve A521 is closed, and fuel transfer is halted when Fuel Tanking Computer A506 senses that the fuel tanks are 100 percent full with respect to the predetermined differential pressure programed into the tanking computer.

6. The fuel density computer senses the differential fuel pressure between upper and lower pressure probes in fuel tank F-4 and determines fuel density.

7. Actual fuel density is compared with propellant loading tables to determine the required fuel pressure head correction.

8. The correction factor is programed into the tanking computer and the fuel quantity digital indicator panel indicates that more than 100 percent (approximately 102 percent) of the required fuel has been tanked.

d. Transfer Line Drain. Upon completion of the slow fill sequence, the filling operation is automatically stepped to the transfer line drain sequence and residual fuel is drawn from the transfer lines and pumped back to the fuel storage tank. This sequence occurs as follows:

1. In response to a command from Fuel Tanking Computer A506, slow fill Pneumatic Valve A521 and booster line Pneumatic Valve A519 are closed. Line drain Pneumatic Valve A520 and power drain Pneumatic Valve A518 are opened.

2. Transfer pump A502 is started, and fuel is pumped from Storage Tank A501 through Strainer A511, Pneumatic Valve A520, Jet Eductor A514, Pneumatic Valve A518 and back into the storage tank through Manual Valve A524. Fuel flow through the jet eductor draws fuel from the transfer line and into the storage tank through Pneumatic Valve A518 and Manual Valve A524.

e. Termination Sequence. Automatic filling operations are complete upon termination of the line drain sequence. The absence of fuel in the transfer line causes Liquid Level Sensor A552 to initiate a 3-minute timer that programs the following sequence.

1. Fuel Transfer Pump A502 is stopped.

2. Discharge Pneumatic Valve A516 is closed.

3. Line drain Pneumatic Valve A520 is closed.

4. Power drain Pneumatic Valve A518 is closed.

1.4.2.2 Level Adjust Drain. Following the fill operation a semi-automatic level adjust drain operation is initiated to drain excess fuel from the S-I fuel tanks. After the tanks have been drained to the desired level, the operation is terminated with a transfer line drain sequence and a purge of the fuel filling mast.

a. The level adjust drain operation occurs as follows:

1. The ADJUST LEVEL DRAIN pushbutton on the RP-1 control panel is pressed to initiate the sequence.

2. The fuel tanking computer transmits a signal to Pneumatic Relay A559 which, in turn, opens level adjust Flow Regulator A522.

3. Fill and drain Pneumatic Valve B111 is opened.

4. Fuel from the S-I stage tanks flows into the transfer line through Pneumatic Valve B111, Quick-Disconnect Coupling B112, Retractable Coupling Assembly A4500, the fuel filling mast and Flow Regulator A522.

5. When the fuel tanks are drained to within 101 percent of the desired fuel level, the fuel tanking computer signal to Pneumatic Relay A559 initiates a gradual closure of Flow Regulator A522. The regulator is fully closed when the fuel tanking computer senses that the tanks are 100 percent filled.

6. With the LINE INERT-RESET switch on the RP-1 control panel turned to the LINE INERT position, the feedback signal from Flow Regulator A522 commands closure of Pneumatic Valve B111. Completion of the level adjust drain operation is signaled by the ADJ. LEVEL COMPLETED indicator on the RP-1 control panel.

7. The fuel tanking digital indicator panel indicates that the fuel tanks are 100 percent filled.

b. Transfer Line Drain. With the LINE INERT-RESET switch on the RP-1 control panel set to the LINE INERT position, fuel transfer lines are automatically drained as follows:

1. Flow Regulator, A522, Pneumatic Valve A519, Pneumatic Valve A520, and Pneumatic Valve A518 are opened.

2. Transfer Pump A502 is started.

3. From the transfer pump, fuel is discharged through Strainer A511, Pneumatic Valve A520, Jet Eductor A514, and Pneumatic Valve A518 and is returned to fuel Storage Tank A501 through Manual Valve A524.

4. Fuel flow through Jet Eductor A514 induces fuel from the transfer line through Pneumatic Valve A519, Flow Regulator A522, and Pneumatic Valve A516.

5. From Jet Eductor A514, the induced fuel flows into fuel Storage Tank A501 through Pneumatic Valve A518 and Manual Valve A524.

c. Mast Purge. Immediately following the transfer line drain sequence, the fuel filling mast purge is initiated. When most of the fuel is drained from the transfer line, Liquid Level Sensor A552 senses the absence of fuel and starts a 3-minute timer that energizes circuits to the MAST PURGE, three-way toggle switch on the RP-1 control panel. The purge sequence occurs as follows:

1. The MAST PURGE, toggle switch on the RP-1 control panel is turned to the AUTO position.

2. A solenoid valve located in the launcher is opened by a signal from the toggle switch, and allows GN_2 at 750 psig to flow into the fuel filling mast through Check Valve A4501.

1.4.2.3 Replenish. Apart from the normal countdown sequence, an automatic fuel replenish operation may be performed when fuel requirements for a launch are increased after the level adjust drain operation has been performed. The replenish operation consists of a replenish sequence and a line drain sequence. Prior to the initiation of the replenish operation, a fuel differential pressure, based on new propellant loading requirements, is dialed into the fuel tanking computer panel. Since the new differential pressure is greater than the existing fuel differential pressure, the fuel quantity digital indicator panel indicates that the fuel tanks are less than 100 percent filled. The operation is performed in four steps: initial setup, replenish, line drain, and termination.

a. Initial Setup. The following prerequisites must be satisfied before the replenish operation is initiated.

1. Manual Valves A523 and A524 must be open.

2. Manual Valve A591 must be closed, and Manual Valve A590 must be open.

3. The POWER switch on the RP-1 control panel must be positioned to ON and the FUNCTION SELECTOR switch must be at the OPERATE position.

b. Replenish. The replenish sequence occurs as follows:

1. The REPLENISH pushbutton on the RP-1 control panel is pressed.

2. Fast fill Pneumatic Valve A517, slow fill Pneumatic Valve A521 and fill and drain Pneumatic Valve B111 are opened. Booster line Pneumatic Valve A519 remains closed.

3. A command signal starts Transfer Pump A502 which provides a 2000-gpm fuel flow into the transfer lines via fast fill Pneumatic Valve A517.

4. The command signal that starts the fuel transfer pump also initiates a 30-second timer that programs the transfer line fast fill sequence. During

this 30-second interval, the transfer lines are rapidly filled at a rate of 2000 gpm.

5. At the end of this 30-second interval, the 30-second timer initiates closure of fast fill Pneumatic Valve A517. Fuel flow to the S-I stage fuel tanks continues through slow fill Pneumatic Valve A521 and Orifice A551 but at a reduced rate of 200 gpm. Liquid Level Sensor A553 is a backup for the 30-second timer and can initiate closure of the fast fill valve when a positive fuel level is detected in the transfer line.

6. Fuel flows to the fuel filling mast through Strainer A575 and Check Valve A580.

7. From the fuel filling mast, fuel flows into the S-I stage fuel tanks through Retractable Coupling Assembly A4500, Quick-Disconnect Coupling B112 and fill and drain Pneumatic Valve B111.

8. As the fuel level in the tanks rises, air is displaced through fuel vent Pneumatic Valves B260-1 and B260-2.

c. Line Drain. When Fuel Tanking Computer A506 senses that the S-I fuel tanks are 100 percent filled, the computer generates a signal that steps the sequence from replenish to line drain.

d. Termination. The replenish operation is complete at the termination of the line drain sequence.

1.4.2.4 Drain. Also apart from the normal countdown sequence, an automatic drain operation may be performed to drain fuel from the S-I fuel tanks in the event of a launch cancellation. The drain operation progresses automatically upon initiation of a command from the RP-1 control panel, and is performed in three steps: initial setup, drain and termination.

a. Initial Setup. The following criteria must be satisfied prior to initiation of the sequence.

1. Manual Valves A523, A524, and A590 must be open.

2. Fuel vent Pneumatic Valves B260-1 and B260-2 must be open.

3. Fast fill Pneumatic Valve A517, Slow fill Pneumatic Valve A521 and Manual Valve A591 must be closed.

4. The POWER switch on the RP-1 control panel must be positioned to ON and the FUNCTION SELECTOR switch must be positioned to OPERATE.

b. Drain. The automatic drain sequence occurs as follows:

1. The DRAIN pushbutton on the RP-1 control panel is pressed.

2. Power drain Pneumatic Valve A518, booster line Pneumatic Valve A519, level adjust Flow Regulator A522, and fill and drain Pneumatic Valve B111 are opened.

3. Fuel flows from fuel tanks F-1, F-2, F-3, and F-4, through Pneumatic Valve B111 and Quick-Disconnect Coupling B112.

4. From Quick-Disconnect Coupling B112, fuel enters the fuel filling mast through Retractable Coupling Assembly A4500 and passes through Pneumatic Valve A519, Flow Regulator A522, Strainer A575, discharge Pneumatic Valve A516, Check Valve A534, and Pneumatic Valve A518.

5. From the power drain valve the fuel enters Storage Tank A501 through Manual Valve A524.

6. When the fuel tanks are less than 10 percent full, Fuel Tanking Computer A506 generates a signal that starts Transfer Pump A502 and causes line drain Pneumatic Valve A520 to open.

7. From Transfer Pump A502, fuel is discharged through Pneumatic Valve A520, Jet Eductor A514, and power drain Pneumatic Valve A518, and is returned to Storage Tank A501 through Manual Valve A524.

8. Fuel flow through Jet Eductor A514 draws any remaining fuel in the S-I stage fuel tanks, fuel filling mast, or transfer line into the storage tank through Pneumatic Valve A518 and Manual Valve A524.

c. Termination. When the last remaining fuel is drained from the transfer lines, the automatic drain sequence is terminated with the following shutdown sequence:

1. The absence of fuel in the transfer lines causes Liquid Level Sensor A552 to initiate a 3-minute timer.

2. At termination of the 3-minute timer cycle, Transfer Pump A502 is stopped.

3. Line drain Pneumatic Valve A520, power drain Pneumatic Valve A518, booster line Pneumatic Valve A519, level adjust Flow Regulator A522, and fill and drain Pneumatic Valve B111 are closed.

1.4.3 Engine Fuel Supply Operations (Figure 3-2) - Engine fuel supply operations include: a preflight fuel bubbling sequence, a fuel tank pressurization sequence, inboard and outboard engine cutoff, and prevalve operation.

1.4.3.1 Fuel Bubbling. Preflight bubbling of fuel within the fuel tanks and the fuel tank suction lines is done to reduce temperature stratification of the fuel, and thereby improve engine start characteristics. GN_2 bubbling of RP-1 in each suction line begins just before the LOX tanks are filled to 10 percent for leak check. A 290-psig GN_2 bubbling supply is routed from valve panel No. 10 through short cable mast No. 2 and enters the S-I stage through Quick-Disconnect Couplings A6505 and B370. Twenty-micron Filter Assembly B373 removes contaminants as the GN_2 enters the vehicle fuel bubbling manifold. The GN_2 is routed through individual supply lines to each engine RP-1 suction line. Orifice Assemblies B372, mounted in each supply line, reduce the supply pressure and protect the suction line from overpressure surges. Check Valves B371, mounted downstream from each orifice, prevent reverse flow of RP-1 into the bubbling manifold in the absence of GN_2 pressure. The GN_2 passes through Pneumatic Valves (prevalves) B103 and through the fuel tanks before being vented out of the tanks through fuel vent Pneumatic Valves B260-1 and B260-2. Fuel bubbling continues until the beginning of the automatic countdown sequence at T-150 seconds. At this time, the fuel vent valves close, and pressurization of the fuel tanks is begun.

1.4.3.2 Fuel Tank Pressurization. Fuel tank pressurization consists of a preflight pressurization sequence and an in-flight pressurization sequence.

a. Preflight Pressurization. Preflight pressurization is provided from GN_2 spheres which are pressurized with 3000-psig GN_2 from valve panel No. 9 (volume V). The GN_2 passes through Filters B254, Electropneumatic Valves B255, and Orifices B256 which prevent pressure surge damage to the fuel tanks and associated lines. Operation of the electropneumatic valves is controlled by Pressure Switch B261 on fuel tank F-3. The pressure switch controls the admission of GN_2 by closing the electropneumatic valves when tank pressure reaches 17 (±0.3) psig and by opening the valves when tank pressure drops 0.5 to 2.0 psig. Preflight switch calibration is provided by Manual Valve B262 which is capped before vehicle launch. Overpressure protection for the fuel tank pressurization system during preflight pressurization is provided by fuel vent Pneumatic Valves B260-1 and B260-2 which vent pressure in excess of 19 (±0.5) psig. These valves are actuated by 750-psig GN_2 routed from valve panel No. 9 by way of Quick-Disconnect Couplings A3062 and B264.

b. In-Flight Pressurization. Fuel tank pressure is maintained during S-I flight by a 3000-psig supply of GN_2 from two 20-cubic-foot pressure spheres. Tank pressurization utilizes Electropneumatic Valves B255, Orifices B256, and Pressure Switch B261 in the same manner as described in the preceding paragraph during the initial portion of powered flight. As pressure decays in the GN_2 spheres, Electropneumatic Valves B255-1, -2, and -3 are sequenced out of the fuel tank pressurization switch control circuit at set intervals. At liftoff and for 39 seconds thereafter, all three valves are slaved to fuel tank Pressure Switch B261. At 39 seconds after liftoff, B255-1 is disenabled, at 54 seconds after liftoff B255-3 is disenabled, and finally at 70 seconds B255-2 is disenabled. Seventy seconds after vehicle liftoff, fuel tank pressure and vehicle acceleration are sufficient to meet fuel pump inlet and tank structural pressure requirements for the remainder of powered flight.

1.4.3.3 Engine Operation and Cutoff. During engine operation, fuel flows from each fuel tank into two suction lines, through Pneumatic Valves (prevalves) B103, and to the inlet side of the H-1 engine fuel pumps. Two seconds after the fuel level in tanks F-2 and F-4 drops below Liquid Level Sensors B104-1 and B104-2 or the LOX level falls below liquid level sensors in LOX tanks O-2 and O-4, a signal is transmitted to the inboard engine Conax valves to shut down the inboard engines (engines 5, 6, 7, and 8). When fuel depletion is normal, the outboard engines are shut down by a 6-second timer that is initiated at inboard engine cutoff. If, during the interval of the 6-second timer, the fuel level falls below Liquid Level Sensors B125 in fuel tanks F-2 and F-4, the sensors fire the outboard engine Conax valves before the timer cycle is completed. This backup for the 6-second timer is provided to insure that sufficient fuel remains in the tanks for a fuel-rich engine cutoff. The position of the sensors is such that approximately 4,680 pounds of fuel is retained.

1.4.3.4 Prevalve Operation. Pneumatic Valves (prevalves) B103 are pneumatically-actuated, normally-closed, shutoff valves. They are used to control fuel flow to the H-1 engines. The prevalves are actuated by 750-psig GN_2 control pressure from the vehicle control pressure system. The prevalves are closed as part of the normal H-1 engine cutoff sequence or in the event of an engine malfunction. GN_2 from the 750-psig GN_2 distribution Manifold B211 is controlled by normally-closed Solenoid Valves B217. When Solenoid Valves B217 are opened, GN_2 flows through Orifices B218 and opens the prevalves. The prevalves are closed by closing Solenoid Valves B217,thereby removing the pneumatic supply to the prevalves.

In the event of individual engine failure during flight, the dead engine Conax valve signals Solenoid Valve B217 to close Pneumatic Valve B103, thus shutting off fuel flow to the dead engine. The lower fuel tank interconnecting manifold then distributes dead-engine fuel to the other engines. At outboard engine cutoff, the amount of fuel in the dead-engine fuel tank exceeds the individual amounts contained in the other fuel tank by approximately 10 gallons.

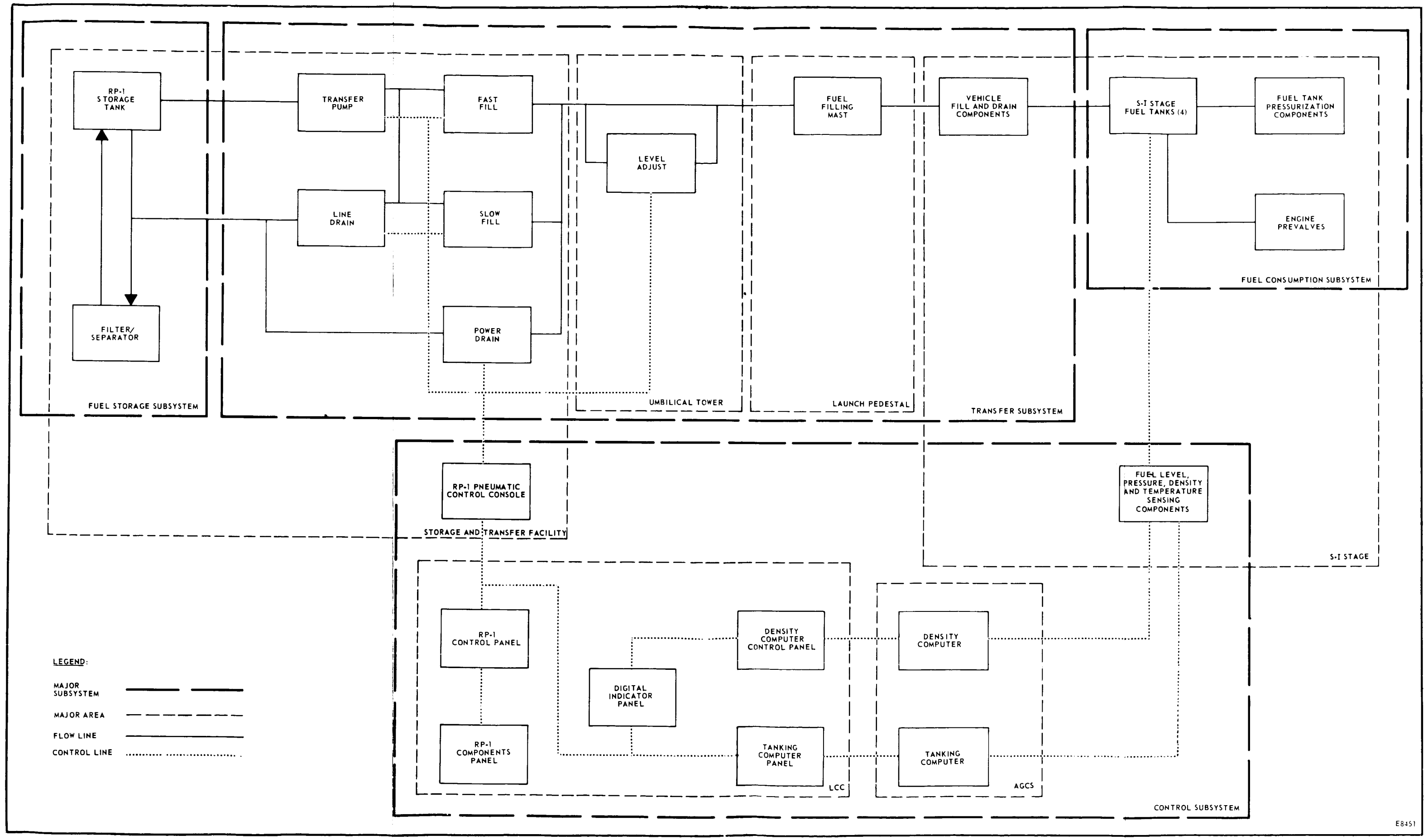

Figure 1-1. Launch Vehicle SA-10 and Launch Complex 37B RP-1 Fuel System - Block Diagram

SECTION 2

INDEX OF FINDING NUMBERS

This section contains an alpha-numerical list, by finding number, of the RP-1 fuel system components that function during a prelaunch countdown, during vehicle flight, or in the event of a launch cancellation. The finding numbers listed identify components on system schematic diagrams provided in section 3. Additional columns in the index of finding numbers provide such pertinent information as component description and function, part number, and the supplier's name and part number. A break will occur in the alpha-numeric sequence of finding numbers when a component, or component series is non-functional during countdown, functional only in the event of a malfunction, functional in terms of a maintenance operation only, or is part of another functional system.

The letter prefix of a finding number identifies the component location with respect to the launch complex or an area of the launch vehicle. Letter prefixes used in this eleven-volume set are listed below.

FINDING NUMBER PREFIX	DESIGNATED AREA
A	Launch complex
B	S-I stage
E	S-IV stage
G	Instrument unit
H	Payload

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A501	1	Tank, Storage	56,500 gallons, fuel	Buffalo Tank Co.	10429003	
A502	1	Pump, Transfer	2000 gpm, fuel	Byron Jackson, Division of Borg Warner	Part of 10429100	
A503 is not functionally applicable to this system.						
A504	1	Motor, Transfer Pump	250 hp.		Part of 1042900	
A505 is not functionally applicable to this system.						
A506	1	Computer, Fuel Tanking				
A507	1	Computer, Fuel Density				
A508 through A510 are not functionally applicable to this system.						
A511	1	Strainer	8 in., 2000 gpm, 100 mesh; basket type	Zuon Industries, Inc.	10429110	
A512	1	Strainer	6 in., 2000 gpm. mesh; in line			
A513 is not functionally applicable to this system.						
A514	1	Jet Eductor	4 in. by 4 in. by 3 in. ; 200 gpm	Pemberthy Mfg. Co.	10429108	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A515	1	Shock Arrestor	3 in.; 1000 cu. in. capacity, 6000 cu in. displacement	Cherry-Burrel Corp	10429109	
A516	1	Valve, Pneumatic	6 in., NC, 750 psig; fuel discharge	Hydromatics, Inc.	10429102	
A517	1	Valve, Pneumatic	6 in., NC, 750 psig, fast fill	Hydromatics, Inc.	10429102	
A518	1	Valve, Pneumatic	6 in., NC, 750 psig; power drain	Hydromatics, Inc.	10429102	
A519	1	Valve, Pneumatic	6 in., NC, 750 psig; booster line		10429102	
A520	1	Valve, Pneumatic	4 in., NC, 750 psig; line drain	Hydromatics, Inc.	10429103	
A521	1	Valve, Pneumatic	4 in., NC, 750 psig; slow fill	Hydromatics, Inc.	10429103	
A522	1	Regulator, Flow	2 in., NC, 25 psig control pressure, 3-15 psig signal pressure; level adjust	The Annin Company Model No. 1560	10429098	
A523	1	Valve, Manual	10 in., shutoff	William Powell Co.	10429093	
A524	1	Valve, Manual	6 in., shutoff	Stockham P/N G612	10429095	
A525	1	Valve, Manual	6 in., shutoff	William Powell Co.	10429093	
A526 through A529 are not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A530	1	Valve, Manual	4 in., shutoff	Stockham	10429096	
A531	1	Valve, Manual	3 in., shutoff	Stockham	10429096	
A532	1	Valve, Manual	1 in., drain	Powell Co. P/N 1974		
A533	1	Valve, Manual	3/4 in., drain			
A534	1	Valve, Check	6 in.		10429112	
A535	1	Valve, Check	4 in.		10429120	
A536 through A540 are not functionally applicable to this system.						
A541	1	Valve, Vent and Vacuum	Vents at 0.25 psig above atm press.; vacuum at 0.0625 psig below ambient		Part of 10429003	
A542	1	Valve, Relief	3/4 in., 200 psig approximate setting	Republic Manufacturing Co. P/N 648X-4-12	10429119	
A543	1	Valve, Relief	3/4 in., 200 psig approximate setting	Republic Manufacturing Co. P/N 648X-4-12	10429119	
A544	1	Valve, Relief	3/4 in., 60 psig approximate setting	Republic Manufacturing Co. P/N 648X-3-12	10429099	
A545 is not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A546	1	Valve, Relief	3/4 in., 60 psig approximate setting	Republic Manufacturing Co. P/N 658X-3-12	10429099	
A547 through A549 are not functionally applicable to this system.						
A550	1	Orifice	6 in. union, 3.52 in. dia		10429070	
A551	1	Orifice	4 in. union, 0.8458 in. dia		10429071	
A552	1	Sensor, Liquid Level	1-1/4 in.	Weighing and Controls Inc.	10429121	
A553	1	Sensor, Liquid Level	1-1/4 in.			
A554 through A556 are not functionally applicable to this system.						
A557	1	Air Eliminator	4 in., N.O.	Valve and Primer P/N 149C	10429117	
A558	1	Air Vent	4 in., air reservoir and flame arrestor			
A559	1	Relay, Pneumatic				
A560 and A561 are not functionally applicable to this system.						
A562	1	Gage, Pressure Compound	1/4 in., 30 psig Mercury suction		10429123	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A563	1	Gage, Pressure	1/4 in., 4-1/2 in. dial, 0 to 3000 psig range		10429122	
A564 and A565 are not functionally applicable to this system.						
A566	1	Switch, Pressure	Actuates at 39 (±4) psig		10429113	
A567	1	Coupling	3 in.	Ever-Tite		
A568 through A572 are not functionally applicable to this system.						
A573	1	Valve, Manual	1/4 in., shutoff	Powell P/N 1976		
A574 is not functionally applicable to this system.						
A575	1	Strainer	8 in., 2000 gpm, reverse flow, 100 mesh, basket type	J.A. Zurn Manufacturing Division	10429111	
A576 and A577 are not functionally applicable to this system.						
A578	1	Switch, Temperature	Normal actuation at 110 F; 80 to 110 F range		10429118	
A579 is not functionally applicable to this system.						
A580	1	Valve, Check	3 in., cracks at 0.5 psig	Valve and Primer Corp.	10429068	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A581	1	Valve, Manual	3 in., shutoff	Stockham	10429097	
A582 through A589 are not functionally applicable to this system.						
A590	1	Valve, Manual	8 in., shutoff		10429067	
A591	1	Valve, Manual	8 in., shutoff		10429067	
A592 is not functionally applicable to this system.						
A593	1	Valve, Relief	3/4 in., NC, relieves at approximately 200 psig			
A594	1	Valve, Relief	3/4 in., NC, relieves at approximately 200 psig			
A595 through A600 are not functionally applicable to this system.						
A601	1	Valve, Manual	3 in., shutoff	Stockham P/N G-612B-OR	10429066	
A602	1	Valve, Relief	Relieves at 5 (±0.5) psig			
A603 through A606 are not functionally applicable to this system.						
A607	1	Coupling	3 in.	Ever-Tite		

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A608 through A2849 are not functionally applicable to this system.						
A2850	1	Valve, Manual	1/4 in., vent	Futurecraft Corporation P/N 30205	10437647	
A2851	1	Gage, Pressure	0-10,000 psig range, normal indication 3500 psig	U.S. Gauge Company Model No. 5003	10437648	
A2852	1	Valve, Manual	5/16 in., shutoff	Robbins Aviation P/N SSNA-375A-6T	10437684	
A2853	1	Valve, Manual	1/4 in., vent	Futurecraft Corporation P/N 30205	10437647	
A2854	1	Regulator, Pneumatic	3500 psig to 750 psig	Grove Valve &Regulator Company, Model No.94X P/N M-12954-A	10437651	
A2855	1	Valve, Relief	Relieves at 900 (±50) psig reseats at 750 psig min.	Republic Manufacturing Co., P/N 625B-9-6	10437652	
A2856	1	Gage, Pressure	0-1500 psig range; 750 psig normal indication	U.S. Gauge Company Model No. 5003	10437688	
A2857	1	Valve, Manual	1/4 in., vent	Futurecraft Corporation P/N 30205	10437647	
A2858	1	Valve, Manual	5/16 in., shutoff	Robbins Aviation P/N SSNA-375A06T	10437684	
A2859	1	Valve, Manual	1/4 in., vent	Futurecraft Corporation P/N 30205	10437647	
A2860	1	Filter	10 micron	Permanent Filter Corp. P/N 10813	10437650	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2861	1	Orifice	0.015 orifice	Made from 10437706 or AN929-6C	10436539	
A2862	1	Snubber, Pressure	70 cc/min nominal flow at 45 psig	Chemiquip Company P/N AC14	10341147	
A2863	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. P/N 202873-113	10437618	
A2864	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. P/N 202873-113	10437618	
A2865	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. P/N 202873-113	10437618	
A2866	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. P/N 202873-113	10437618	
A2867	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. P/N 202873-113	10437618	
A2868	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. P/N 202873-113	10437618	
A2869	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 202873-113	10437618	
A2870	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 202873-113	10437618	
A2871	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 202873-113	10437618	
A2872	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 202873-113	10437618	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2873	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. P/N 202873-113	10437618	
A2874	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. P/N 202873-113	10437618	
A2875	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. P/N 202873-113	10437618	
A2876	1	Valve, Solenoid	3-way, 2-position, N.O.	Marotta Valve Corp. P/N 202873-113	10437618	
A2877	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 202873-113	10437618	
A2878	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 202873-113	10437618	
A2879	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 202873-113	10437618	
A2880	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 202873-113	10437618	
A2881	1	Valve, Manual	1/4 in., vent	Hoke, Inc., Series 280 P/N 4PY281	10437696	
A2882	1	Switch, Pressure	Actuates at 750 (± 50) psig; deactuates at 6000 psig min	Barksdale Valves P/N 320-13S	10437754	
A2883	1	Switch, Pressure	Actuates at 1500 (± 200) psig deactuates at 1000 psig min	Barksdale Valves P/N 320-13S	10437753	
A2884 through A2887 are not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2888	1	Orifice	1/32 in. orifice dia.	Made from AN 820-4C	10428611	
A2889 is not functionally applicable to this system.						
A2890	1	Valve, Manual	3/8 in., shutoff	Robbins Aviation Series G-375 P/N SSNG-375A-6T	10428551	
A2891	1	Orifice	1/32 in. orifice dia.	Made from AN 820-4C	10428611	
A2892	1	Orifice	1/32 in. orifice dia.	Made from AN 820-4C	10428611	
A2893	1	Orifice	1/32 in. orifice dia.	Made from AN 820-4C	10428611	
A2894	1	Orifice	1/32 in. orifice dia.	Made from AN 820-4C	10428611	
A2895	1	Orifice	1/32 in. orifice dia.	Made from AN 820-4C	10428611	
A2896	1	Orifice	1/32 in. orifice dia.	Made from AN 820-4C	10428611	
A2897	1	Orifice	1/32 in. orifice dia.	Made from AN 820-4C	10428611	
A2898 through A3048 are not functionally applicable to this system.						
A3049	1	Coupling, Quick Disconnect	1/4 in.	E. B. Wiggins Oil Tool Co., Inc. P/N 6200R79A4	75M-02221	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A3050	1	Coupling, Quick Disconnect	1/4 in.	E. B. Wiggins Oil Tool Co., Inc., P/N 6200R79A4	75M-02221	
A3051	1	Coupling, Quick Disconnect	1/4 in.	E. B. Wiggins Oil Tool Co., Inc. P/N 6200R79A4	75M-02221	
A3052 through A3061 are not functionally applicable to this system.						
A3062	1	Coupling, Quick Disconnect	3/8 in.	E. B. Wiggins Oil Tool Co., Inc. P/N 6300R105A6	75M-02217	
A3063 through A4499 are not functionally applicable to this system.						
A4500	1	Coupling Assembly, Retractable	90 psig operating pressure	Flexonics Corporation P/N 107435	10426984	
A4501	1	Valve, Check	Cracks at 0.5 to 1.0 psig	James Pond &Clark P/N 239T-4TT	10426502	
A4502 through A4504 are not functionally applicable to this system.						
A4505	1	Vacuum Breaker	3/4 in., NC	OPW Corporation P/N 476L-3/4		
A4506 through A6500 are not functionally applicable to this system.						
A6501	1	Coupling, Quick Disconnect				
A6502 through A6504 are not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A6505	1	Coupling, Quick Disconnect				
A6506 through B100 are not functionally applicable to this system.						
B101	1	Coupling, Quick Disconnect		E. B. Wiggins Oil Tool Co., Inc. P/N 6105A4B4	20M30136	
B102 is not functionally applicable to this system.						
B103-1	1	Valve, Pneumatic	8 in., NC, shutoff, 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0018	20M30043	9A26
B103-2	1	Valve, Pneumatic	8 in., NC, shutoff, 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0018	20M30043	9A29
B103-3	1	Valve, Pneumatic	8 in., NC, shutoff, 750 psig normal operating pressure	Parker Aircraft Co. F61C0018	20M30043	9A32
B103-4	1	Valve, Pneumatic	8 in., NC, shutoff, 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0018	20M30043	9A35
B103-5	1	Valve, Pneumatic	8 in., NC, shutoff, 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0018	20M30043	9A38
B103-6	1	Valve, Pneumatic	8 in., NC, shutoff, 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0018	20M30043	9A41
B103-7	1	Valve, Pneumatic	8 in., NC, shutoff, 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0018	20M30043	9A44
B103-8	1	Valve, Pneumatic	8 in., NC, shutoff, 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0018	20M30043	9A47

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B104-1	1	Sensor, Liquid Level		Acoustica Associates Incorporated P/N 102310	20C30430-1	9A63
B104-2	1	Sensor, Liquid Level		Acoustica Associates Incorporated P/N 102310	20C304 0-1	9A69
B105 through B108 are not functionally applicable to this system.						
B109	1	Switch, Pressure		Servomechanisms Inc. P/N 816106	20C30154	9A24
B110	1	Valve, Manual	3-way, shutoff	Benton Corporation P/N B15600	10414076	
B111	1	Valve, Pneumatic	NC, shutoff, fill and drain, ball-rotor	Parker Aircraft Co. P/N F61C0018	20C30043	9A23
B112	1	Coupling, Quick Disconnect	1/4 in.	E.B. Wiggins Oil Tool Co., Inc. P/N 6105A4, B4	20M30136	
B113 is not functionally applicable to this system.						
B114	1	Coupling, Quick Disconnect	1/4 in.	E.B. Wiggins Oil Tool Co., Inc. P/N 6005R79A4	20M30139	
B115	1	Coupling, Quick Disconnect	1/4 in.	E.B. Wiggins Oil Tool Co., Inc. P/N 6005R79A4	20M30139	
B116	1	Coupling, Quick Disconnect	1/4 in.	E.B. Wiggins Oil Tool Co., Inc. P/N 6005R79A4	20C30139	
B117 through B124 are not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B125	2	Sensor, Liquid Level	Fuel depletion	Acoustics Associates Inc. P/N 102570 Mod. NAF-120	60C20003	
B126 through B216 are not functionally applicable to this system.						
B217-1	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 21863-113 (MV-74)	20C30128	9A25
B217-2	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 21863-113 (MV-74)	20C30128	9A28
B217-3	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 21863-113 (MV-74)	20C30128	9A31
B217-4	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 21863-113 (MV-74)	20C30128	9A34
B217-5	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 21863-113 (MV-74)	20C30128	9A37
B217-6	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 21863-113 (MV-74)	20C30128	9A40
B217-7	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 21863-113 (MV-74)	20C30128	9A43
B217-8	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 21863-113 (MV-74)	20C30128	9A46
B218	8	Orifice	0.046 (+0.001, -0.000) in. dia		60C20039	
B219 through B253 are not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B254	3	Filter	3/4 in.	Permanent Filter Corp P/N 20030	20C30129	
B255-1	1	Valve, Electropneumatic	2-way, 2-pos, NC	Marotta Valve Corp. P/N 225314-2	60C20360	11A47
B255-2	1	Valve, Electropneumatic	2-way, 2-pos, NC	Marotta Valve Corp. P/N 225314-2	60C20360	11A49
B255-3	1	Valve, Electropneumatic	2-way, 2-pos, N.O.	Marotta Valve Corp. P/N 225314-2	60C20360	11A49
B256	3	Orifice	0.2374 (+0.001, -0.000) in. dia	Parker Aircraft	20C30197	
B257 through B258 are not functionally applicable to this system.						
B259	2	Valve, Relief	NC, vents at 23 (±1.0) psig		20C30020	
B260-1	1	Valve, Pneumatic	NC, 750 psig actuating pressure, fuel vent		20C30000	11A45
B260-2	1	Valve, Pneumatic	NC, 750 psig actuating pressure, fuel vent		20C30000	11A45
B261	1	Switch, Pressure		Southwestern Industries Inc. P/N PS-5703-17	60C20056	11A50
B262	1	Valve, Manual	3-way, calibration	Benton Corporation P/N B-15600	1414087	
B263 is not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B264	1	Coupling, Quick Disconnect	1/4 in.	E.B. Wiggins Oil Tool Co., Inc. P/N 6005R79A4	20C30139	
B265 through B369 are not functionally applicable to this system.						
B370	1	Coupling, Quick Disconnect	1/4 in.	E.B. Wiggins Oil Tool Co., Inc. P/N 6005R79A4	20C30139	
B371	8	Valve, Check	1/4 in., fuel bubbling	James Pond and Clark, Inc. P/N P279T-4BB (L)	20C30125	
B372	8	Orifice Assy	Fuel bubbling		20C30198	
B373	1	Filter Assy	Fuel bubbling	Cosmic-Fairchild P/N 30599	20C30428	
B374 through B501 are not functionally applicable to this system.						

SECTION 3

MECHANICAL SCHEMATICS

This section contains mechanical schematics that show the functional arrangement of RP-1 fuel system components listed in section 2.

For a definition of the mechanical symbols used, see MSFC-STD-162A.

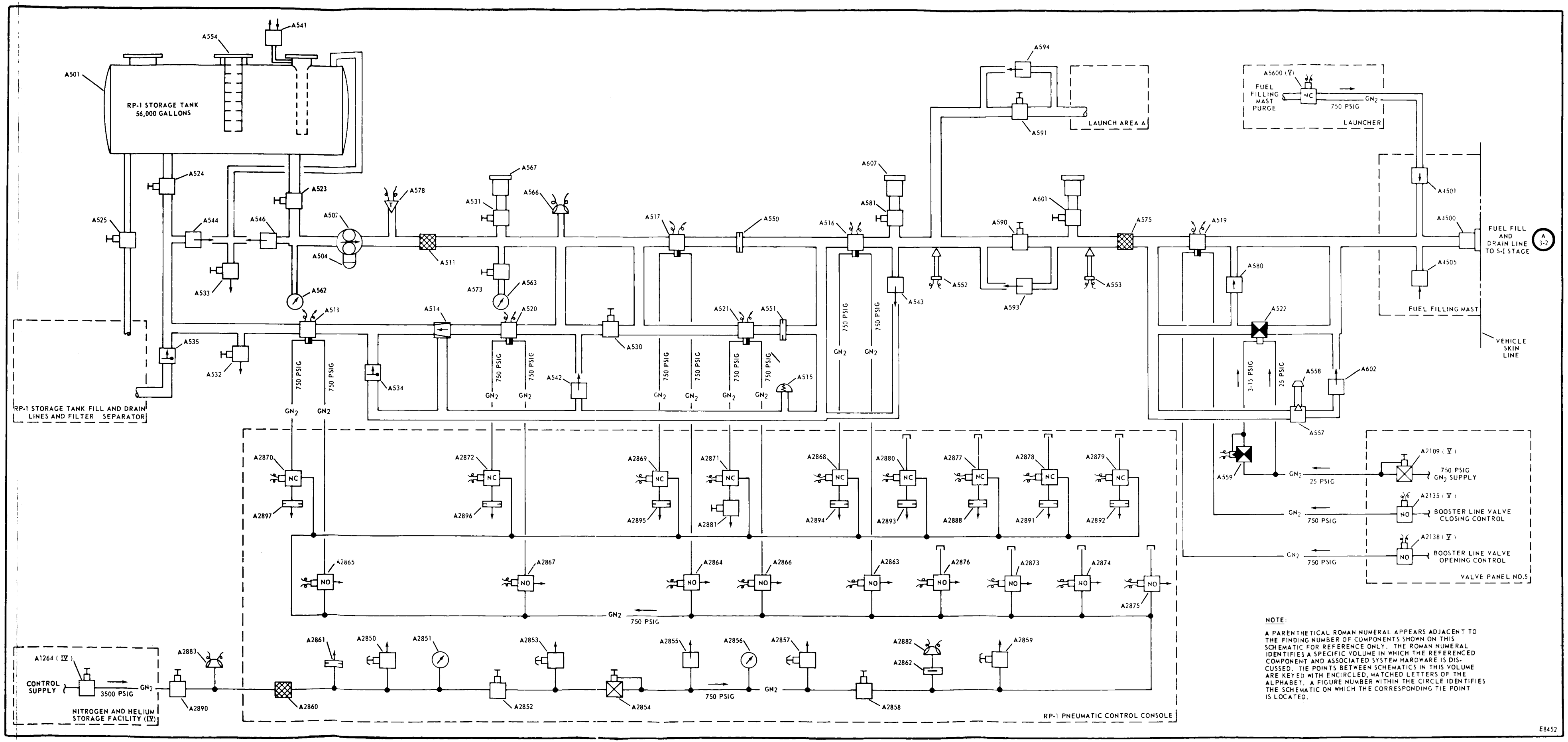

Figure 3-1. Launch Complex Fuel Storage and Fuel Transfer Subsystems - Mechanical Schematic

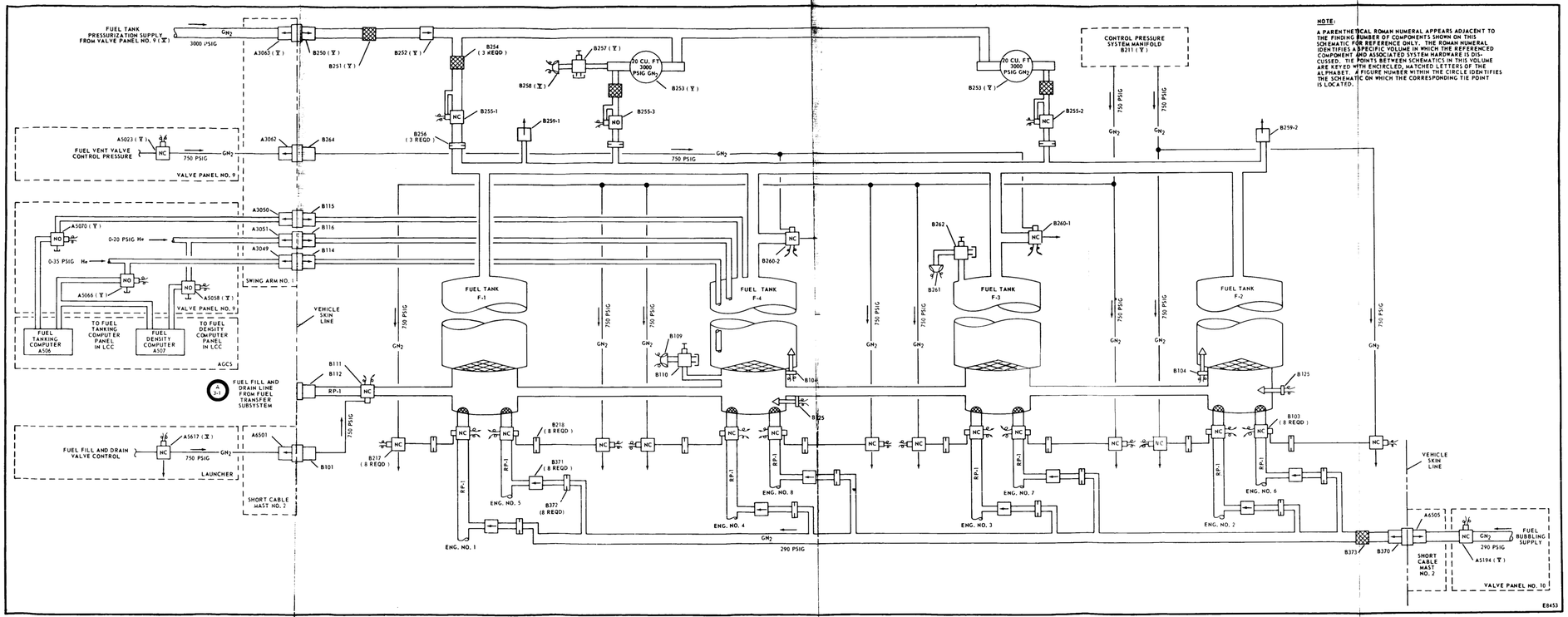

Figure 3-2. S-I Stage Fuel System Components and Subsystems - Mechanical Schematic